

**DEVICE FOR CONNECTING AN INDUSTRIAL CONTROL UNIT TO AN
INDUSTRIAL CONTROL PANEL**

[001] This is a Continuation of International Application PCT/DE00/02243, with an international filing date of July 10, 2000, which was published under PCT Article 21(2) in German, and the disclosure of which is incorporated into this application by reference.

FIELD OF AND BACKGROUND OF THE INVENTION

[002] The present invention relates generally to a device having an industrial control unit, an industrial control panel, and a communication link. More specifically, the present invention is directed to a device and method for providing a simple and economical communication interface between functional units of an industrial control panel and an industrial control unit.

[003] Industrial control panels generally have several front-mounted functional units in addition to a flat display which serves as a display unit. In particular, these functional units include, (i) an operator keyboard which can be designed as a membrane keyboard or short-stroke keyboard, (ii) a touch screen input unit for the display-controlled input of user commands, (iii) a mouse, or -- as a substitute for a mouse-- a pointer, for example in the form of a touch pad, roller ball, or piezo pad, (iv) status displays, which can be designed as LEDs, and (v) key displays which give the user information on current allowed and disallowed operations, for example. The functional units may also be communication interfaces for the connection of additional control devices and output devices such as bar code readers, printers, and

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an operator keyboard, and for the temporary connection of mass storage devices such as CD-ROM drives, CD-ROM burners, LS120 drives, and zip drives.

[004]

The functional units of a control panel are each connected to an industrial control unit via individual communication links, using a corresponding number of lines. This industrial control unit controls a technical process such as an industrial production device, and can be designed as a memory-programmable control or an industrial PC, for example. Conventionally, connections between the control panel and the control unit have been made by using different protocols and different interfaces on the side of the industrial control unit, such as COM1, COM2, LPT, PS2 mouse, PS2 keyboard, an FD interface, and/or an ATAPI CD-ROM interface, and occasionally, non-standardized proprietary customized solutions. There are disadvantages to this approach, however, such as a marked reduction in the allowed line length, and limited industrial suitability, such as low resistance to interference in the connecting lines due to the physical transmission characteristics.

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[005]

The fundamentals for data transmission using USB interfaces are known from a publication by G. Bassak, "USB Eases Data Acquisition" from Test and Measurement World, Vol. 18, No. 6, and a publication by M. Rowe, "USB Proves Ready for T & M Tasks." U.S. Patent 5, 675, 813 describes a system and a method for power transmission to a computer via a USB bus system.

OBJECTS OF THE INVENTION

[006]

One object of the invention, therefore, is to provide a device having an industrial control unit, an industrial control panel, and a communication link that does not have the aforementioned disadvantages. A further object is to provide an industrial control panel that does not have the aforementioned disadvantages.

SUMMARY OF THE INVENTION

[007]

In accordance with the present invention, the above-mentioned objects, as well as other objects, are achieved by a device having an industrial control unit, an industrial control panel and a communication link. The industrial control panel further has at least two functional units, each of which has a respective USB controller. The control panel also has an integrated USB hub which connects the USB controllers to the respective functional units of the control panel. Also, the industrial control panel is connected to the industrial control unit via the communication link such that control signals can be sent to or from the control unit from or to the control panel and its corresponding functional units via the USB hub.

[008]

One of the advantages of the present invention lies in the fact that the control panel can be connected to the industrial control unit via a single communication link. Examples of an industrial control unit include an office PC, an industrial PC, or an embedded computer. Since the allowed line length of this communication link is significantly increased compared to known connections between industrial control units and industrial control panels, the claimed device simultaneously satisfies the requirements of installing the control panel spatially separate from the industrial control unit and—in addition to a flat display line and the power supply—connecting to the industrial control unit via a single, inexpensive two-wire connection. A device in accordance with the present invention allows limited installation space or special environmental conditions to be taken into consideration, if necessary.

[009]

Furthermore, the hub functionality employed in the claimed connection allows several control panels to be simultaneously connected to a single industrial control unit via a single connecting line. This assures the unambiguous identification of the respective control components within the overall system.

BRIEF DESCRIPTION OF THE DRAWINGS

[010] The invention and further advantageous refinements of the invention according to the features of the dependent claims are explained in more detail below with the aid of diagrammatic, exemplary embodiments in the drawing, in which:

[011] **Figure 1** illustrates a device in accordance with one embodiment of the present invention comprising an industrial control unit, an industrial control panel, and a communication link according to the invention, and

[012] **Figure 2** shows a device comprising an industrial control unit and an industrial control panel according to a further embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[013] Figure 1 shows a device with an industrial control unit 1 and an industrial control panel 2. The control panel has several functional units 4, 5, 7, 8. Reference number 4 represents a mouse, for example, reference number 5 represents a touch screen input unit, for example, reference number 7 represents a light diode status display, for example, and reference number 8 represents an input keyboard, for example. Each of these functional units is assigned its own respective USB controller 4a, 5a, 7a, 8a which converts data present in each of the functional units into USB format, and vice versa. The term "USB format" refers to a data format which has become standardized in the personal computer field, and which performs serial data conversion on a universal serial bus (USB).

[014] Each of the USB controllers 4a, 5a, 7a, 8a is connected to a USB hub 9, which is integrated into the control panel 2. The USB hub relays data sent to it by the functional units, together with the respective associated address information, to a single communication link 1b. Communication link 1b is preferably a USB line and is connected to a USB interface 1c of the industrial control unit 1.

[015]

The control panel 2 also has a front USB interface 6a which is connected to an additional device. The additional device can be an external control device (not shown), a display device 3, or an external mass storage device (not shown). The external mass storage device can be, for example, a printer, external keyboard, external mouse, external bar code reader, PC-PC coupling, CD-ROM device, CD burner, LS120 floppy disk drive, IOMEGA zip drive, or any other compatible device.

[016]

Thus, according to the present invention each of the functional units present in the control panel 2 is connected via individual USB controllers to an integrated USB hub 9, which in turn is connected via a single USB line 1b to the industrial control unit 1. The advantages of such a device lie in the fact that a simple and economical communication link is created via only a single line 1b to the industrial control unit 1, at which location a standardized USB interface can be used. Hence, commercially available drivers, such as drivers for the Microsoft Windows operating system, can be used in conjunction with the present invention. Furthermore, in accordance with the invention, additional external control, output, and mass storage devices can be connected to the industrial control unit 1 via the control panel 2. Since the allowed line length of USB line 1b is greater than 5 meters, the control panel 2 can also be installed spatially separate from the industrial control unit 1.

[017]

Figure 2 shows a device for connecting an industrial control unit 1 to an industrial control panel 2 according to a further embodiment of the invention. According to this embodiment, an additional USB hub 10 is assigned to the control panel 2. The additional hub may be provided spatially separate from the control panel, or it may be integrated into the control panel. The additional USB hub 10 is connected to the functional units of the control panel 2 via a first USB line 12. In addition,

graphics data is transmitted between the control panel 2 and the USB hub 10 via a line 13.

[018]

The additional USB hub 10 is also connected to an external receiver 15 via a cable 14, with the cable comprising a USB line and a graphics line. The receiver 15 is connected to an additional control panel 18 via a USB line 16 and a graphics line 17. Control panels 2 and 18, shown in Figure 2, have the same design as control panel 2, previously described in conjunction with Figure 1.

[019]

The additional USB hub 10 is connected to the industrial control unit 1 via a cable 11 which has a USB line and a graphics line. The lengths of the respective cables 11 and 14 can vary from 10 to 15 meters. Thus, in this exemplary embodiment two control panels which are installed at separate locations are connected via USB lines to an industrial control unit 1 which is spatially separate from the control panel 2. Accordingly, only a single cable leading to the industrial control unit 1 is necessary. A USB hub installed near or in the control panel is used to distribute data fed to the various control panels and to combine data sent from the control panels.

[020]

The above description of certain embodiments of the present invention has been given by way of example. From the disclosure given, those skilled in the art will not only understand the present invention and its attendant advantages, but will also find apparent various changes and modifications to the structures and methods disclosed. It is sought, therefore, to cover all such changes and modifications as fall within the spirit and scope of the invention, as defined by the appended claims, and equivalents thereof.